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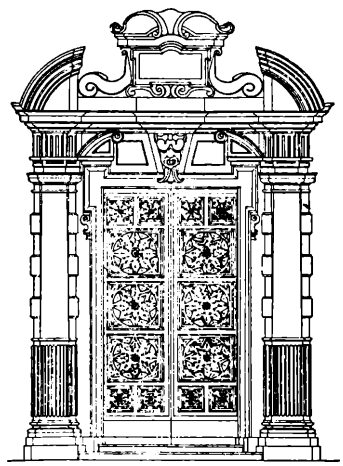
The poorly known Andean Lizard *Liolaemus uspallatensis* Macola & Castro 1982, and its intrageneric relationships: a taxonumerical approach (Reptilia, Iguanidae)

J. A. Scolaro - J. M. Cei



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José A. Scolaro* – José M. Cei**

The poorly known Andean Lizard *Liolaemus uspallatensis* Macola & Castro 1982, and its intrageneric relationships: a taxonumerical approach. (Reptilia, Iguanidae).

ABSTRACT

A discriminant analysis supported nearby morphological relationships between the poorly known Andean Lizard *Liolaemus uspallatensis* Macola & Castro, 1982 and species of the sub-Andean *"darwini"* group, such as *L. darwini* and *L. boulengeri*. The interest of the femoral scale patch as a significant character state in systematics and phylogeny of the genus *Liolaemus* was pointed out. Unpublished iconographic features of *Liolaemus uspallatensis* were presented.

Introduction

Liolaemus uspallatensis Macola & Castro 1982 is a taxon whose original description was a very deficient one (Laurent, 1984; Cei, 1986), being still very poor our present knowledge about its natural history and ecology. The further redescription by Laurent (1984) provided a more suitable morphological information about this slender Cordilleran tropidurine Lizard: general affinities with the surrounding pre-Andean populations of *Liolaemus darwini* from the same geographical area were postulated.

The present contribution was got in shape to support such a latter evolutionary trend and probable phyletic features by means of other critical kinds of evidence. With this purpose a discriminant analysis of somatic characteristic variables has been used, as in former similar papers (Scolaro and Cei, 1987; Cei and Scolaro, 1987), either for *Liolaemus uspallatensis* or representative taxa of

* Centro Nacional Patagónico (CENPAT. CONICET), Puerto Madryn, Chubut, Argentina.
** Departamento Ciencias Naturales, Universidad Nacional de Rio Cuarto, Córdoba, Argentina.

the sympatric *"darwini"* and *"ruibali"* groups. Comparative chromatic differences between living specimens of all these tropidurine forms are also shown by means of color slides taken in their natural environments.

Materials and methods

For a suitable testing with several individual samples, a basic matrix of data from four taxa was primarily constructed as follows; N or sample numbers, Argentine localities, acronyms of museological or personal collections where specimens are deposited, are given below.

Liolaemus uspallatensis: (N=16), Uspallata, 2000 m, prov. Mendoza; MRSN (Museo Regionale Scienze Naturali, Torino, Italy); JMC-DC (José M. Cei-Diagnostic Collection),

Liolaemus eleodori: (N=33), Parque Provincial San Guillermo, 4200 m, prov. San Juan; MCZ-R (Museum Comparative Zoology-Reptiles, Harvard University, Cambridge, USA); IADIZA-CH (Instituto Argentino Investigaciones Zonas Aridas-Colección Herpetologica, CONICET, Mendoza),

Liolaemus ruibali: (N=34), Quebrada del Toro, Uspallata, 2500 m, Mendoza; Paramillo, Uspallata, 3000 m, Mendoza; Tocota plateau, 2600 m, prov. San Juan; MZUF (Museo Zoologico Universitá di Firenze, Italy); JMC-DC,

Liolaemus boulengeri: (N=30), Volcán Payún, Arroyo Batra, Meseta Payunia, 1800 m, prov. Mendoza; IADIZA-CH; MZUF.

Furtherly an additional discriminant analysis was carried out, replacing *L. boulengeri* with *Liolaemus darwini,* a closely related species of its morphoecological group, to strenght the postulated relationships of these forms with *L. uspallatensis,* longtime confused with Cordilleran simpatric populations of the *ruibali* group. Sample number, localities, acronyms of museological collections are also given below for *Liolaemus darwini.*

Liolaemus darwini: (N=32), Carrizal del Medio, 650 m, prov. Mendoza; Challao, near Mendoza town, 900 m; Volcán Payún, 2000 m, Meseta Payunia, prov. Mendoza; S. Rafael, prov. Mendoza; 10 km N Matagusanos, 800 m, Talacasto, prov. San Juan; 10 km NW Caucete, prov. San Juan; Vallecito, prov. San Juan; 5 km San Antonio, San Juan-La Rioja boundaries; MRSN; MZUF.

All morphometric measurements were taken on adult specimens, whose maturity was confirmed by dissections. Thirteen continuous and discontinuous wariables were selected in accordance with the available descriptions of the above mentioned taxa, all corresponding to the whole metric characters reported in table 1. A numerical evalutation of chromatic patterns in the estab-

Table 1 - Comparative mensural characters of the species. Values represent Mean and Standard Deviation (SD).

Variables	*L. eleodori* (N = 33)		*L. uspallatensis* (N = 16)		*L. ruibali* (N = 34)		*L. darwini* (N = 32)		*L. boulengeri* (N = 30)	
Snout-vent length (mm)	65.9	(4.7)	57.5	(2.6)	55.8	(5.3)	55.7	(3.4)	58.9	(5.6)
Head length (mm)	14.7	(1.0)	11.9	(0.7)	10.9	(1.0)	11.1	(0.8)	11.6	(1.0)
Head width (mm)	12.5	(1.2)	10.5	(0.6)	10.2	(0.9)	9.9	(0.7)	10.1	(0.9)
Fore limb length (mm)	22.7	(1.4)	21.9	(1.4)	18.7	(1.3)	19.0	(1.7)	19.4	(1.9)
Hind limb length (mm)	34.0	(2.7)	36.6	(3.6)	31.2	(2.9)	33.1	(2.6)	31.1	(2.4)
Axilla-groin length (mm)	35.1	(3.0)	25.9	(1.9)	25.0	(3.2)	25.5	(2.2)	26.6	(3.0)
Supralabial scale number	9.1	(0.9)	9.1	(0.8)	8.8	(0.7)	7.6	(0.6)	8.1	(0.6)
Infralabial scale number	5.6	(0.5)	6.4	(0.8)	5.4	(0.5)	5.6	(0.7)	6.4	(0.7)
Scale number around midbody	89.3	(5.4)	79.5	(7.7)	78.3	(7.0)	56.2	(0.9)	68.2	(4.0)
Fourth finger lamellae	16.8	(1.4)	20.7	(1.2)	18.3	(1.2)	18.7	(1.7)	18.1	(1.5)
Fourth toe lamellae	22.3	(1.3)	28.9	(2.4)	23.4	(1.0)	25.5	(1.7)	25.1	(1.6)
Femoral scale patch (%)	0		28.1	(8.5)	0		51.6	(30.4)	51.7	(33.4)
Ventral pigmentation (%)	31.1	(19.5)	17.2	(17.0)	36.8	(22.9)	26.6	(17.6)	51.7	(22.3)

lished groups was added to the statistical treatment with discontinuous variables. The "ventral pigmentation" was arranged to give a numerical value for the individual expression of ventral melanophore density, supported by a gradual arbitrary scale (Fig. 1.A), as formerly proposed (Scolaro and Cei, 1987).

Other meristic variable, usually named "femoral patch" is here considered by means of the gradual arbitrary scale shown in Fig. 1.B.

All data have been treated by means of the discriminant analysis according to Foucart's method (1982). Variables showing significant difference between groups were analyzed for normalcy by means of Snedecor's F Test. When normal Gaussian distributions were observed, the comparison between means was made by the Student Test. When character distributions were not normal, the Mann-Whitney U Test or Z test (big samples) has been used.

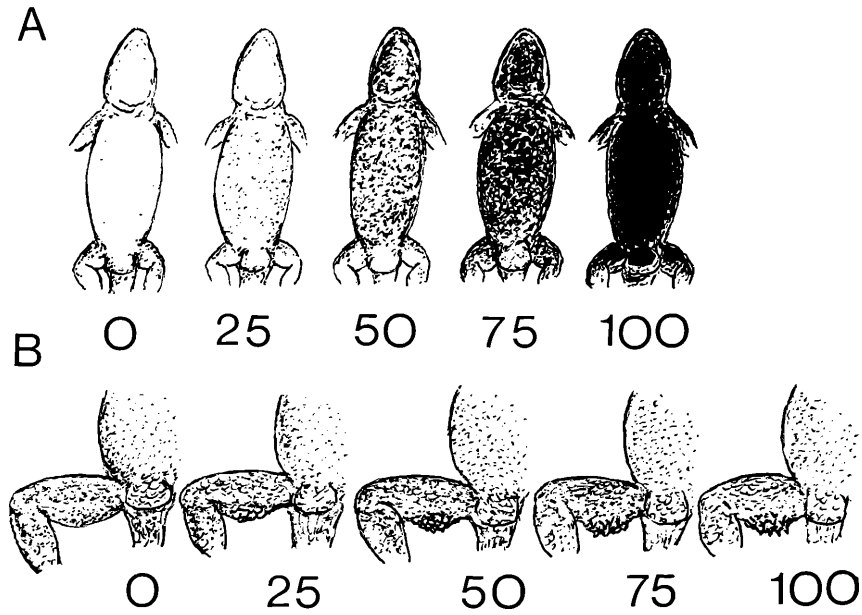


Fig. 1 - Arbitrary scale of the discontinuous variable referable to: A - The ventral pigmentation (melanophore density) in the *"darwini"* and *"ruibali"* groups - 0, absent or very scarce chromatophores; 25, darker pigmentation; 50, high melanophore density; 75, very dark, almost melanic pigmentation; 100, ventral melanism (quite unknown in these groups). B - The morphological expression of the femoral patch, an ambi-sexual somatic character of the *"darwini"* group - 0, absent in both sexes; 25, slightly recognizable in male, indistinct in female; 50, well recognizable in male, moderate in female; 75, remarkable in male, evident in female; 100, outstanding character in male, strong in female.

RESULTS

The groups submitted to a discriminant analysis assembled samples of *Liolaemus eleodori, L. ruibali* and *L. boulengeri* populations. Two canonic axes were obtained, absorbing 52% and 48% of the total variance. The variables and the associated groups by the axes are shown (Table 2). The axis I allows separation of *L. boulengeri* from the remaining groups by a major expression for the variables "ventral pigmentation" ($P<0.001$), "fourth toe lamellae" ($P<0.001$) and "number of infralabials" ($P<0.001$), as well as by a minor expression for the variables "scale number around midbody" ($P<0.001$) and "supralabial scale number" ($P<0.01$). This taxon also exhibits the morphological variable "femoral patch", absent in the remaining taxa included in the present analysis. The canonic axis II allows discrimination of *L. eleodori* from *L. ruibali.* In its positive sector it associates with a major expression variables of *L. eleodori* such as "body length" ($P<0.001$), "head length" ($P<0.001$), "head width" ($P<0.001$) and "axilla-groin length" ($P<0.001$). The negative sector of

Table 2 - Discriminant components of variables and squared cosine of group's centroids on the canonic axes.

Variables	Discriminant Component Axis	
	I	II
Snout-vent length	0.23	0.97
Head length	0.35	0.93
Head width	0.55	0.83
Hind limb length	0.35	0.93
Fore limb length	0.52	0.85
Axilla-groin length	0.38	0.92
Supralabial scale number	0.97	0.25
Infralabial scale number	-0.98	0.22
Scale number around midbody	0.86	0.51
Fourth finger lamellae	-0.39	-0.92
Fourth toe lamellae	-0.92	-0.40
Femoral scales patch	-0.99	0.02
Ventral pigmentation	-0.97	-0.25
	Squared cosine of centroids	
Liolaemus eleodori	0.27	0.73
Liolaemus ruibali	0.23	-0.77
Liolaemus boulengeri	-0.99	0.01

this axis associates *L. ruibali* with a major expression for the variable "fourth finger lamellae" ($P<0.001$) and with a minor expression for the above mentioned variables, including "scale number around midbody" ($P<0.001$).

A sample of 16 specimens of *Liolaemus uspallatensis* was individually tested in order to checking their association and/or affinity with the above reported taxa, included in the present analysis. All these specimens showed a clear cut association with *Liolaemus boulengeri,* mainly by the presence of the variable "femoral patch", characteristic of this taxon, but absent both in *L. eleodori* and *L. ruibali.* Moreover, the "body size" of *L. uspallatensis* and *L. boulengeri* is almost similar, and not significant differences are shown for the majority of the considered variables, excepting a major expression of *L. uspallatensis* for the variables "scale number around midbody" ($P<0.001$), "fourth finger lamellae" ($P<0.001$), "fourth toe lamellae" ($P<0.001$), and a minor expression for the variable "ventral pigmentation %" ($P<0.001$).

If the means of the remaining variables are compared, *Liolaemus boulengeri* versus *L. eleodori* shows, by its minor body size, a minor expression for all its variables, excepting the variables formerly reported as associated to such a taxon by the canonic axis I. On the contrary, in the case of *L. ruibali,* the larger body size of *L. boulengeri* shows significant differences for "body length" ($P<0.05$), "head length" ($P<0.001$), but a minor expression for "scale number around midbody" ($P<0.001$).

The body size of *L. uspallatensis* is intermediate between *L. eleodori* and *L. ruibali:* thus, it shows versus *eleodori* a minor expression for "body length" ($P<0.001$), "head length" and "head width" ($P<0.001$), "axilla-groin distance" ($P<0.001$), "scale number around body" ($P<0.001$), "ventral pigmentation %" ($P<0.05$), but a major expression for "infralabial scale number" ($P<0.001$) and "fourth finger" and "fourth toe" lamellae ($P<0.001$). In the case of *L. ruibali, L. uspallatensis* stress a major expression of the variables "fore limb length" ($P<0.001$), "hind limb length" ($P<0.001$), "infralabial scale number" ($P<0.001$), "fourth finger" and "fourth toe" lamellae ($P<0.001$), but a minor expression for "ventral pigmentation %" ($P<0.001$).

This discriminant analysis of individual specimens resulted in a very high percentage of correct classification (100%). Ellipses of equiprobability ($P<0.01$: Sokal and Rohlf, 1979) for all specimens revealed no overlap between the considered groups (Fig. 2). a equidistance between the ellipse centroids of the taxa is showed together the spatial distribution of cases of *L. uspallatensis.*

Another discriminant analysis was carried out comparing the taxa *eleodori, ruibali* and *darwini,* this latter sympatric with *uspallatensis* through a noticeable bit of its distribution area. Two canonic axes were obtained, absorbing 53% and 47% of the total variance respectively. Discriminant components of variables and squared cosine of the group's centroids are shown in Table 3. The canonic axis I allows separation of *L. darwini* from the compared remaining groups by its major expression for the variables: "femoral patch"

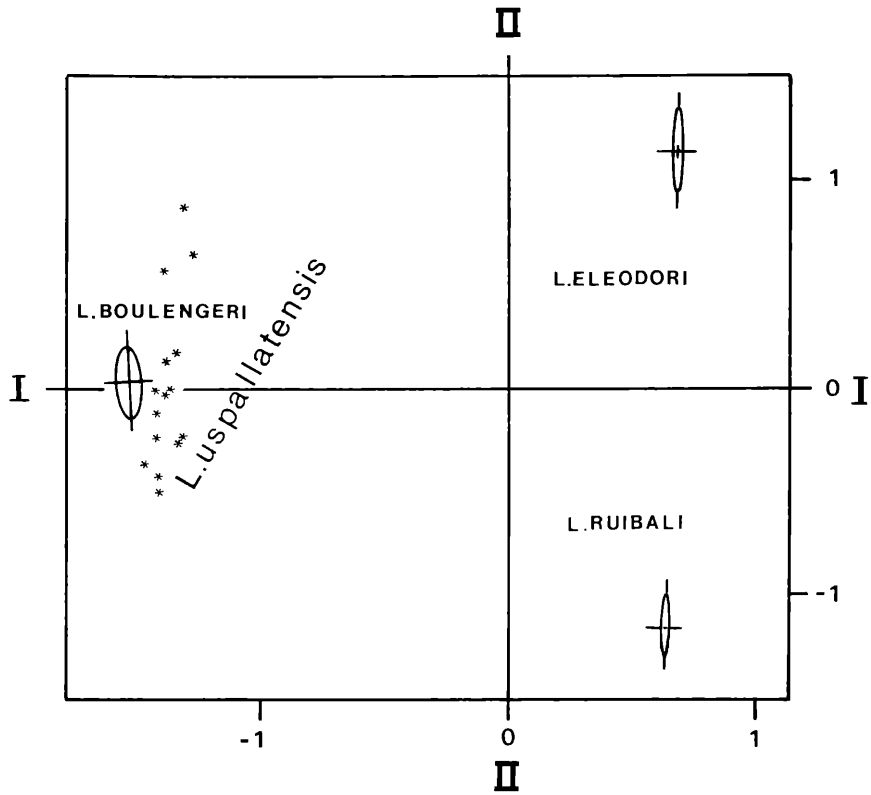


Fig. 2 - Ellipses of equiprobability for all the cases (P< 0.01): *Liolaemus eleodori* (N=33), *L. ruibali* (N=34) and *L. boulengeri* (N=30), checking individual cases of *Liolaemus uspallatensis* (N=16).

(P< 0.001), "fourth finger" and "fourth toe" lamellae (P< 0.001); likewise by its minor expression for the variables "supralabial scale number" (P< 0.001), "scale number around midbody" and "ventral pigmentation %" (P< 0.05). The canonic axis II allows separation of *eleodori* and *ruibali* such as in the previous analysis. This discriminant analysis also shows a very high percentage of correct classifications and the ellipses of equiprobability no overlap (Fig. 3).

When the means of the remaining variables are compared, *Liolaemus darwini,* by its smaller body size, reveals a minor expression versus *L. eleodori* for all the used somatic variables (P< 0.001). If the specimens of *L. uspallatensis* are compared with *L. darwini,* they are all associated with this latter (100%), mainly by the impressive presence of the femoral patch in such a taxon. When the remaining variables are compared, *L. uspallatensis* shows a major expression for all somatic variables versus *L. darwini* (P< 0.001).

Table 3 - Discriminant components of variables and squared cosine of group's centroids on the canonic axes.

Variables	Discriminant Component Axis	
	I	II
Snout-vent length	0.52	0.85
Head length	0.48	0.88
Head width	0.59	0.80
Hind limb length	0.45	0.89
Fore limb length	-0.18	0.98
Axilla-groin length	0.48	0.88
Supralabial scale number	0.99	0.15
Infralabial scale number	-0.43	0.90
Scale number around midbody	0.95	0.30
Fourth finger lamellae	-0.70	-0.71
Fourth toe lamellae	-0.94	-0.33
Femoral scales patch	-0.99	0.03
Ventral pigmentation	0.81	-0.58
	Squared cosine of centroids	
Liolaemus eleodori	0.28	0.72
Liolaemus ruibali	0.24	-0.75
Liolaemus darwini	-0.99	0.01

Discussion

Liolaemus darwini, L. boulengeri and *L. uspallatensis* are easily separated from *L. ruibali* or *L. eleodori* by the presence of a quite evident femoral patch, absent in these latter species. Comparing *Liolaemus darwini, L. boulengeri* and *L. uspallatensis,* this latter exhibits a minor expression for the variables "femoral patch" and "ventral pigmentation", but a major expression for "number of digital lamellae", both in fingers and toes. When it is compared with *L. darwini, L. uspallatensis* shows a major corporal size, as well as a major number of scales at midbody, a character which likewise allows its separation from *L. boulengeri.* Comparing *L. uspallatensis* with *L. boulengeri* also a major expression for the length of its fore limb and hind limb is shown.

Such in the case of the former comparison between *L. uspallatensis* and *L. darwini-L. boulengeri,* the variables "fourth finger" and "fourth toe" lamellae show a major expression when *L. uspallatensis* is compared with *L. ruibali* and *L. eleodori* to. Besides, *L. uspallatensis* strengths a remarkable major expres-

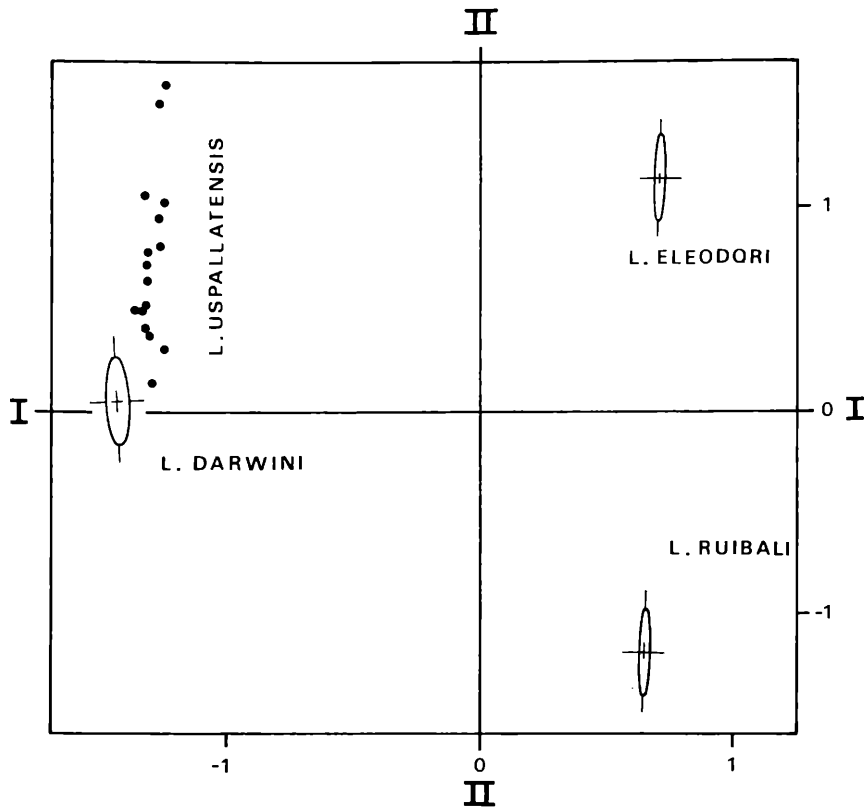


Fig. 3 - Ellipses of equiprobability for all the cases (P<0.01): *Liolaemus eleodori* (N=33), *L. ruibali* (N=34) and *L. darwini* (N=32), checking individual cases of *Liolaemus uspallatensis* (N=16).

sion for the variable "hind limb length" when compared with all considered taxa. However, its medium sized body shows a noticeable minor expression when compared with *L. eleodori* and *L. boulengeri*. It may be added at last that *L. eleodori* is distinguishable from *L. ruibali* by means of its major expression for all morphological variables, including "number of scales around mid-body", excepting the "fourth finger and fourth toe lamellae". About the significant chromatic patterns of the specific coloration of all these taxa, the joined color plates I and II will to detail better their own characteristics in living specimens, in their natural environments.

We like also to mention the agreement between our present remarks and some assumptions dealing with phylogenetic analysis and cladistics carried out in 1988, 1989 by Etheridge as tentative essay on 51 and 35 species of the

genus *Liolaemus* (Etheridge: personal communication). *Liolaemus uspallatensis* belongs in fact at the node *4* (femoral patch adquired) in the above mentioned phylogenetic analysis, together *boulengeri, darwini* and other related forms. However, *Liolaemus ruibali* and *L. eleodori* belong at the lower node *3* (distal part of the diaphisis of the tibia expanded to form a blade-like process). Also in the generated trees for following analysis, *eleodori* and *ruibali* were unquestionably included in the group lacking the femoral patch; on the other hand, nearby relationships between *uspallatensis* and *darwini* were again suggested. If a further comparative information improves, it may be assumed that the bulging femoral scale patch and the related hypertrophy of the proximal part of the posterior head of the *musculus tibialis internus,* stronger in the male, will prove to be a very useful morphological condition in any future taxonomic assessment of the genus *Liolaemus* (Etheridge: pers. comm.).

Conclusions

On the basis of the results of our present discriminant analysis and its discussion, the good specific status of *Liolaemus uspallatensis* is enphasized. The Laurent's remarks (1984) about the probable relationships between such a form and the several species usually assembled in a *"darwini"* group is also supported by multivariate analysis in the case of *L. darwini* and *L. boulengeri.* A general agreement between our numerical findings and tentative cladistic approaches by other Authors may be put in evidence.

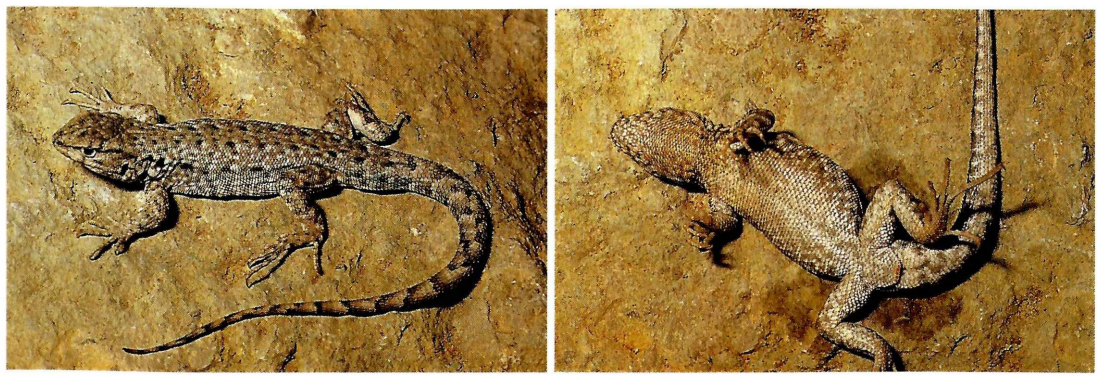
RIASSUNTO

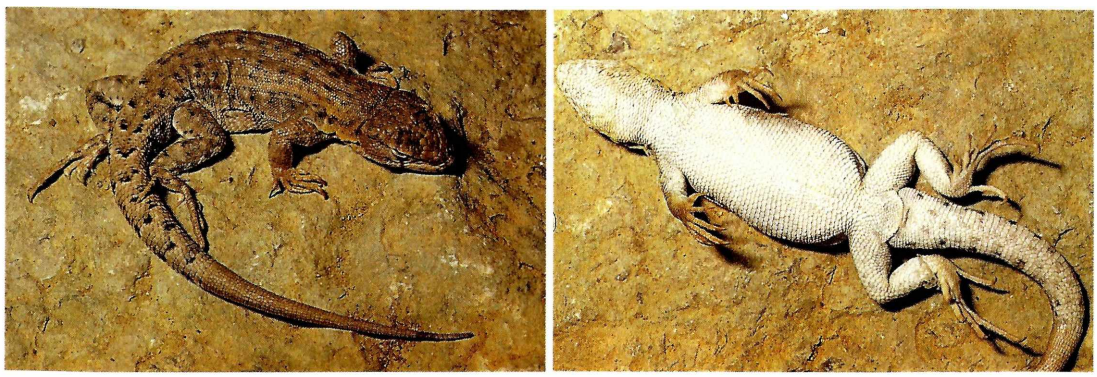
Una analisi discriminante pone in evidenza strette relazioni morfologiche tra lo scarsamente conosciuto iguanide Andino *Liolaemus uspallatensis* Macola e Castro, 1982 e specie del gruppo subandino "*darwini*", quali *L. darwini* e *L. boulengeri.* Risalta dall'analisi l'interesse della rilevante placca femorale a squame ingrandite come carattere significativo nella filogenia e sistematica del genere *Liolaemus.*

Si presentano aspetti iconografici ancora inediti della morfologia e colorazione di *Liolaemus uspallatensis.*

José A. Scolaro
Centro Nacional Patagónico
(CENPAT. CONICET),
Puerto Madryn, Chubut, Argentina

José M. Cei
Departamento Ciencias Naturales
Universidad Nacional de Rio Cuarto
Córdoba, Argentina





1 - *Liolaemus uspallatensis* Macola and Castro 1982. Male specimen from 20 km NE Uspallata, ancient road Uspallata-Villavicencio, 1900 m. Mendoza prov. Col. J. A. Scolaro and E. A. Pereyra, 4-IV-1989.

2 - The same specimen, ventral view: femoral patch evident.

3 and 4 - *Liolaemus uspallatensis,* a female specimen from the same locality, same data: femoral patch present but moderate.

5 and 6 - *Liolaemus ruibali* Donoso Barros 1961. Male specimen from Cruz del Paramillo, 3000 m, ancient road Uspallata-Villavicencio, Mendoza prov. Col. J. A. Scolaro and E. A. Pereyra, 4-IV-1989. Dorsal and ventral views: no femoral patch evident.

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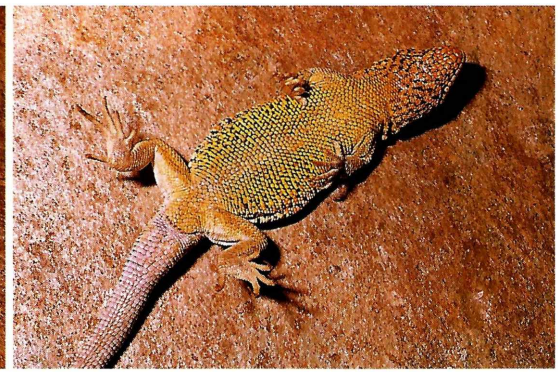

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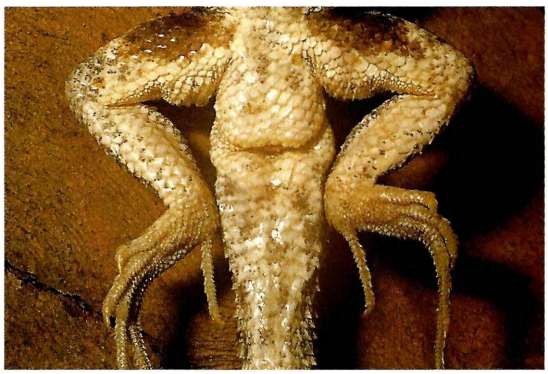

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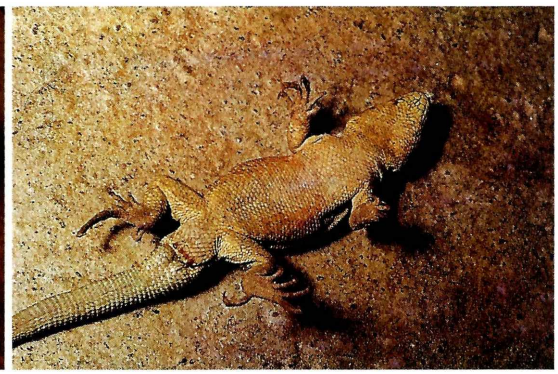

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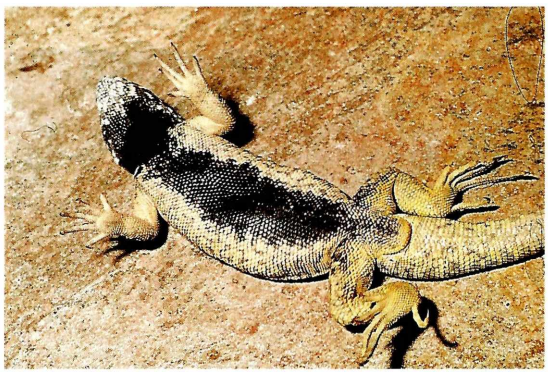

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1 and 2 - *Liolaemus eleodori* Cei, Etheridge and Videla 1983. Male specimen from Parque Provincial San Guillermo, 4200 m, Andean Cordilleran, San Juan Prov., Argentina. Dorsal and ventral views: no femoral patch is present.

3 - Femoral patch in a male specimen of *Liolaemus darwini,* neighborhoods of the capital, Mendoza prov., Argentina, IV-1973.

4 - Femoral patch not evident in a male specimen of *Liolaemus famatinae* from Sierra of Famatina, 4200 m, La Rioja prov., Argentina, III, 1979.

5 - Presence of femoral patch in a male specimen of *Liolaemus fitzingeri canqueli* from Sierra Castillo (South Meseta Canquel), Chubut prov., Argentina. III-1980.

6 - Absence of femoral patch in a male specimen of *Liolaemus bibroni* from Rio Ecker, Santa Cruz prov., Argentina. 7-XII-1980.

All specimens natural size or slightly augmented: photos J. M. Cei.

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